

Nokia's views on USA Spectrum Issues

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Outline

- New Spectrum
- Summary

Nokia Involvement in NAM Spectrum

Regulatory

- FCC
 - Meet directly with the FCC
 - Submit Filings
 - Participate in FCC workshops
 - Invited to: FCC Tech Advisory Council on Spectrum Sharing
 - Demo to US Gov't on Spectrum Sharing
- Industry Canada (IC)
- NTIA
- White House OSTP
- Legislative Branches (Mobile Now Act)
- Commerce Spectrum Management Advisory Committee (CSMAC)

Thought Leadership





- NAM Operators
 - Multiple focused meetings with NAM operators to discuss spectrum issues (auctions, spectrum sharing, 5G, etc)
- Industry Forums, conferences, etc
 - TIA, CTIA, 4G Americas, IEEE DySPAN, IEEE Globecom

Standards

- WINN Forum
 - Specifications of Spectrum Sharing
- 3GPP
 - Generating contributions to add new bands for NAM spectrum
 - Defining performance requirements for CA combinations
- ITU and ATIS
 - Supporting spectrum work in both ITU and ATIS

Media Coverage

Timeline of additional planned NAM Spectrum (FCC's actions)

	1 st H 2014	2 nd H 2014	1 st H 2015	2 nd H 2015	1 st H 2016
	PCS H-Block Auctioned: Feb-2014. Winner: Dish Network		AWS-3 Auctioned: Jan-2015. Sharing uplink w/ US Govt.		600 MHz Auction March 29 th , 2016, ends in 2H2016 Complex Incentive Auction
	700 MHz UHF Auctioned: Feb-2014. Winners: Rogers, Bell, Telus, etc		AWS-3 Auctioned: March-2015. Winners: Bell, Telus, WIND, Videotron, etc	2.6 GHz Auctioned: Apr-2015. Winners: Bell, Telus, Rogers, Videotron, etc	
	2 nd H 2016	1 st H 2017	2 nd H 2017	1 st H 2018	2 nd H 2018
	600 MHz Auction March 29 th , 2016, ends in 2H2016 Complex Incentive Auction	mmWave 27.5-28.35GHz, 37.0-38.6GHz, 38.6-40GHz, 64-71GHz	3.5 GHz General Authorized Access (GAA) 80-150MHz Sharing w/ US Govt and Fixed Satellite Services	5GHz Additional 195MHz 5350-5470 & 5850-5925MHz	3.5 GHz Priority Access Licenses (PALs) Up to 70MHz Sharing w/ US Govt and Fixed Satellite Services
				600 MHz Same band plan as USA	

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US 600MHz Voluntary Incentive Auction

What we know:

- Reverse and forward auctions start on March 29th, 2016.
- FDD with 5 MHz “generic” blocks.
- 416 different service areas (PEAs).
- Interoperability.
- Part 27 technical rules.
- Max. amount of reserved spectrum: 30 MHz
- Prior to forward auction, companies will receive information on “impaired” licenses.
- 2 categories of generic spectrum blocks for bidding in the forward auction:
 - “Category 1” blocks with potential impairments that affect 0-15 % of the population of a geographic area
 - “Category 2” blocks with potential impairments that affect 15-50 % of the population.
- Canada issued a Decision to adopt the same 600 MHz Band Plan as the FCC.

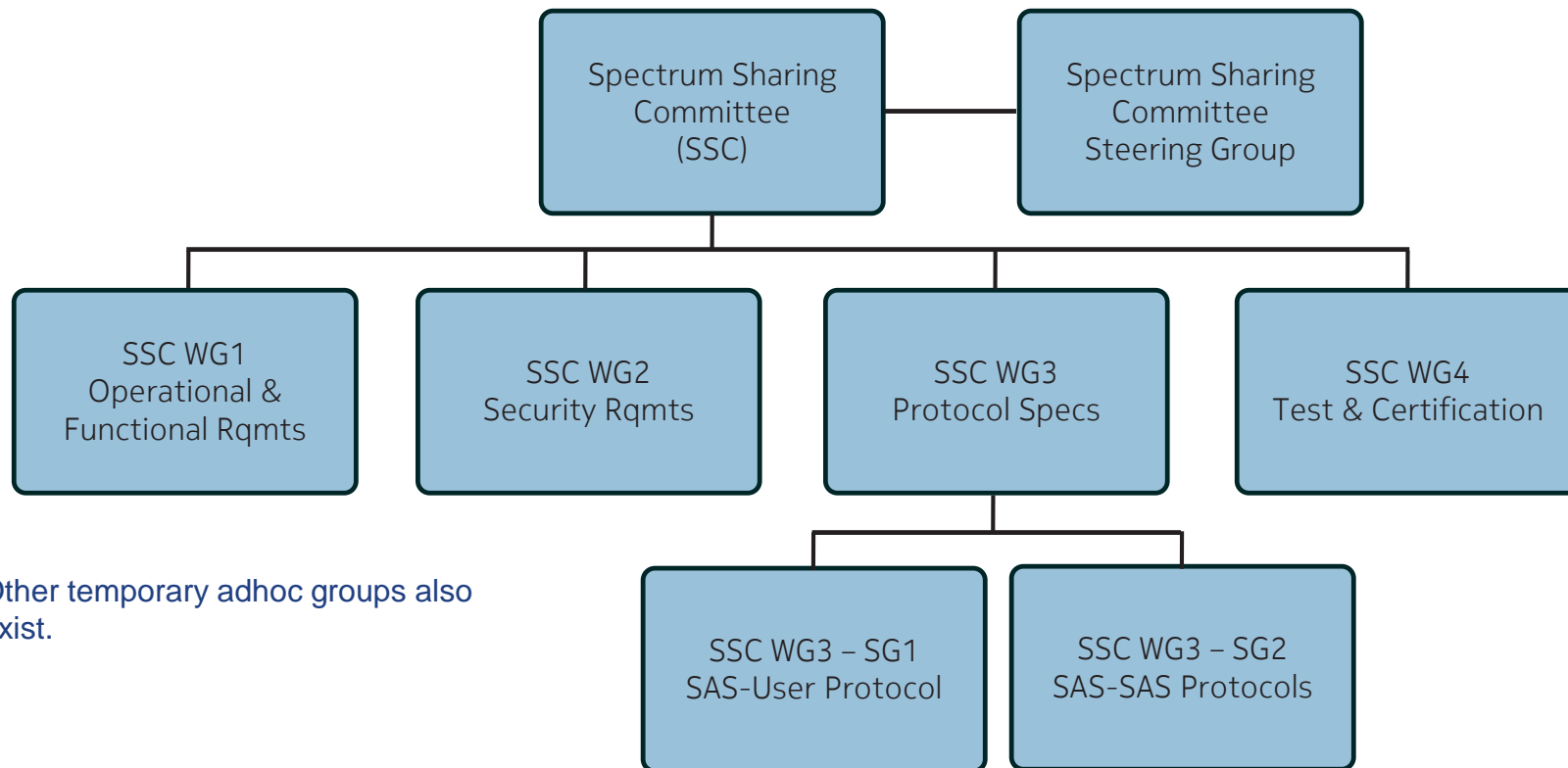
Challenges:

- Amount of spectrum/band plan: Unknown till auction. Heard 114MHz (2x45MHz+guard bands+duplex gap).
 - 3GPP to start work after auction with a band plan. 3GPP band: Q3 2017. Devices: 1H2018. Earliest 1H2018 deployment in some markets pending clearing.
- Potential interference between TV stations assigned to 600MHz and BS/UE on “impaired” channels.
- Unlicensed use in guard bands and duplex gap may create interference issues with licensed services.
 - BS and UE product design implications.
- Auction likely to take months. Afterwards, stations moving to a different TV channel have 3 months to file for new permits / licenses and up to 36 months to transition.
 - Impact to deployment schedule (could be 2020 in some markets although expect acceleration)

FCC 3.5GHz 2nd R&O needed ASAP

- **Defining “Use” of PAL Frequencies**
- **Implementing Secondary Markets in Priority Access Licenses**
- **Optimizing Protections for FSS**
 - **In-band Protection of FSS in the 3650-3700 MHz Band**
 - **Out-of-Band Protection of C-Band FSS Earth Stations**
- **Petitions**
 - **Tx power (increase power, eliminate conducted power & leave EIRP)**
 - **Emissions, measurements procedures**
 - **60s reconfiguration to be increased**
 - 96.15(b)(4): Within 60 seconds after the ESC communicates that it has detected a signal from a federal system in a given area, the SAS must either confirm suspension of the CBSD’s operation or its relocation to another unoccupied frequency.
- **PAL license terms**

WINN Forum Spectrum Sharing Committee (SSC)



Other temporary adhoc groups also exist.

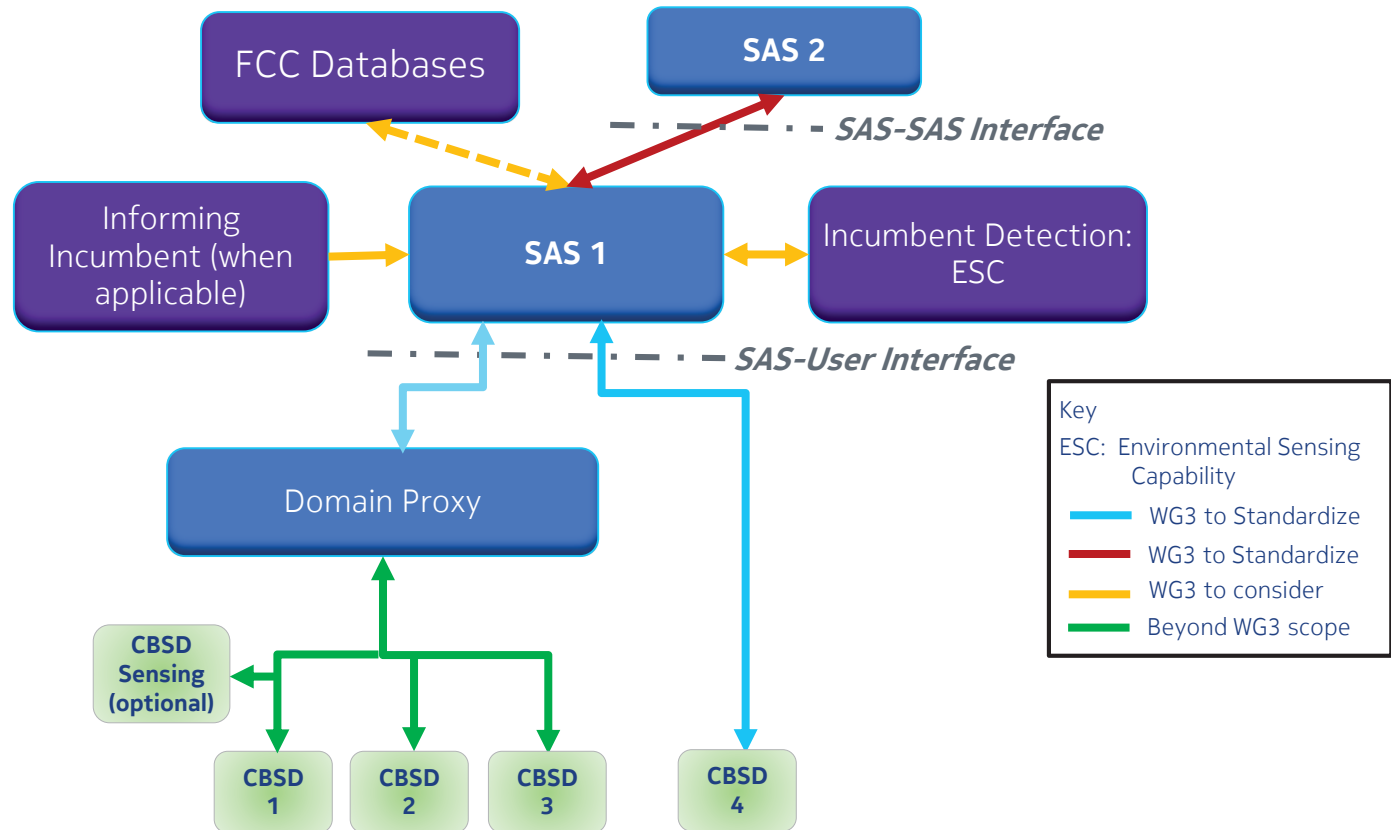
SAS – Notional Architecture

SAS:

- CBSD Registration
- Interference analysis
- Incumbent protection
- PAL license validation
- CBSD channel assignment
- CBSD power limits
- PAL protection
- SAS-to-SAS coordination

SAS Proxy:

- SAS Interface GW including Security
- Directive translation between CBSD and Domain Commands
- Bulk CBSD Directive Processing
- Interference contribution reporting to SAS

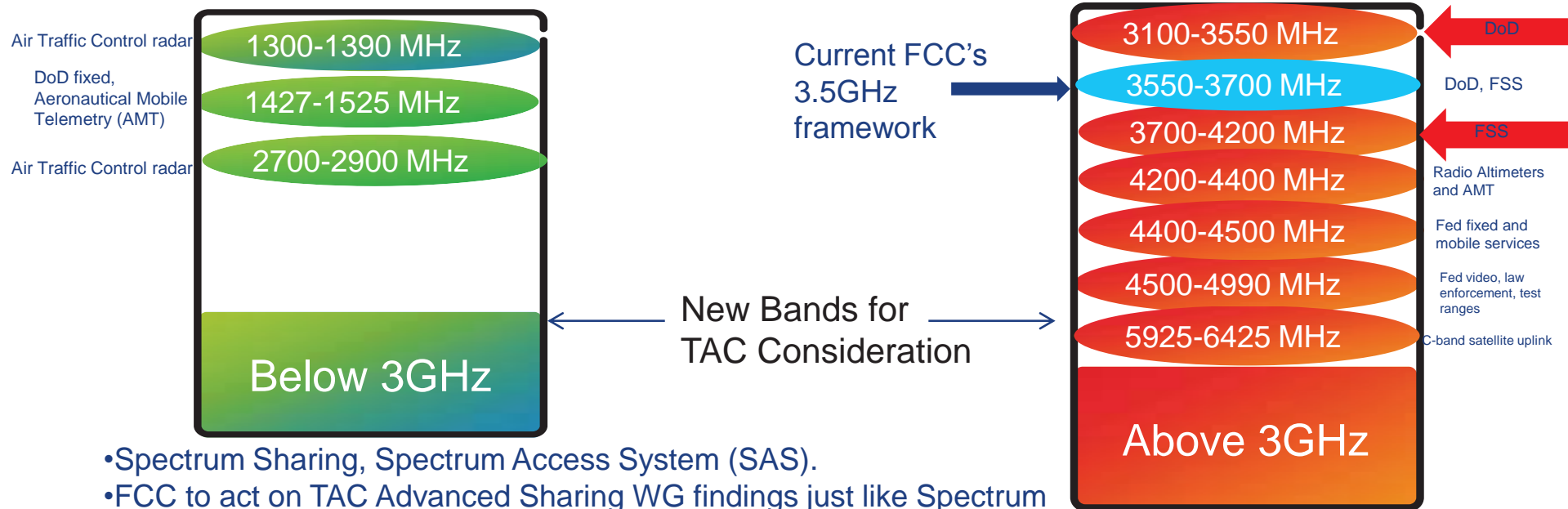


Status Update from WINN Forum

- WG1 (Operational and Function Requirements, Chairs: Andy Clegg, Google and Al Jette, Nokia)
 - SAS Functional Architecture Approved
 - Requirements for Commercial Operation in the U.S. 3550-3700 MHz CBRS Band: April 2016.
 - Different TGs kicked off.
- WG2 (Security Requirements, Chair: Charles Clancy, Federated Wireless)
 - Security Threat Model: February 2016
 - Operational Security Requirements: February 2016
 - Communication Security Requirements: February 2016
- WG3 (Protocols, Chairs: Jesse Caulfield, Key Bridge Global and Prakash Moorut, Nokia)
 - SAS-SAS/SAS-CBSD Interim Technical Reports TR-A Approved
 - SAS-SAS/SAS-CBSD TR-B approved.
 - SAS to CBSD Protocol Specs version 1 (Chair: Prakash Moorut, Nokia): June 2016
 - SAS to SAS Protocol Specs version 1 (Chair: James Ni, Federated Wireless): June 2016
- WG4 (Test and Certification, Chair: Kurt Schaubach, Federated Wireless)
 - High level Certification Flow Approved
 - Test and Certification Objectives: February 2016
 - Test and Certification Requirements Specification: July 2016

Other potential shared bands below 6GHz

FCC Technological Advisory Council (TAC) Advanced Sharing WG



- Spectrum Sharing, Spectrum Access System (SAS).
- FCC to act on TAC Advanced Sharing WG findings just like Spectrum Frontiers WG led to 5G mmW Notice Of Inquiry (NOI).

3700-4200MHz FSS Earth Stations



3700-4200 MHz Earth Stations
TR and RO

Legend

- Earth Stations - RO
- Earth Stations - TR
- Urban Areas

~5000 FSS Earth Stations
Maybe easier for Fixed Wireless to coordinate with the Earth Stations

- RO = receive only means the ES receives from the satellite in the 4 GHz band (3700-4200 MHz)
- TR = transmit/receive means the ES transmits in the 6 GHz band and receives in the 4 GHz band

C-Band Earth Stations

Top Ten Licensees

Licensee / Affiliate	Stations
Associated Press	958
Comcast	518
National Public Radio	358
Time Warner	225
Fox Television / News	188
Alascom, Inc.	187
ABC / Disney	167
GCI Communication Corp.	142
RCN Corporation	115
Intelsat	80



WRC-15 (World Radiocommunication Conference) , 2-27.11.2015, Geneva

Summary of outcome

- WRCs takes place about every 3-4 years, decides the changes in spectrum use
- Member states make the decisions
- More than 20 agenda items, only some are relevant for mobile industry
- Around 3800 participants, representing 162 Member States and 130 other entities, including industry

•470-694/698MHz (e.g. USA, CAN, MEX, NZ)
•1427-1518MHz (global)
•3300- 3400 MHz (India, Africa, LatAm)
•3400-3600MHz (global)
•3600-3700MHz(R2)
•4800-4990MHz (URG, CBD, Lao PDR, VTN)

AI 1.1:Additional spectrum for IMT

694-790MHz: Mobile allocation and identification for IMT confirmed in R1 with conditions that are similar to those of 800MHz.

AI 1.2: 700MHz for IMT in Region 1

Administrations to consider parts of the frequency range 694-894 MHz for PS

AI 1.3:Public Safety

AI for 5G spectrum: agenda item agreed for some bands within 24-86 GHz
AIs for HAPS and RLANS

AI 10: WRC-19 agenda

AI 1.1 (additional spectrum for IMT)

470-694MHz

Region 1 (R1, Europe& Africa): No change (NOC) but a provisional agenda item in WRC-23 (Provisional Final Acts: Resolution COM 4/6)

R2 (Americas): identified for IMT in some countries e.g. Canada, US and Mexico (Footnote (fn) 5.idR2a, 5.idR2b, Resolution 224)

R3 (APAC): identified for IMT in some countries e.g. India, New Zealand (fn 5.idR3)

L-band: 1427-1518MHz

1427-1452MHz: identified for IMT in all regions (R1, R2, R3) (fn 5.R1a, 5.R1b, 5. R2a, 5.R3g, Res 223, COM 4/7)

1452-1492MHz: identified for IMT R2 and R3, and African countries in R1. Available for IMT in CEPT but not identified. (fn 5.R1b, 5.R2a, 5.R3h)

1492-1518MHz: identified for IMT in all regions (R1, R2, R3) (fn 5.R1a, 5.R2a, 5.R3g)

3300-3400MHz

3300-3400MHz: identified for IMT in R1 in a number of African countries but not CEPT (fn 5.R1a, 5.R1b, Res 223)

R2 in Argentina, Colombia, Costa Rica, Ecuador, Mexico and Uruguay (fn 5.B11, 5.C11, Res 223)

R3 in Cambodia, India, Lao, Pakistan, Philippines and Viet Nam (fn 5.R3d, 5.R3e, Res 223)

3400-3800MHz

3400-3600MHz: Identified for IMT in all regions (R1, R2, R3) (fn 5.430, 5.IMT, 5:432B, 5.433A)

3600-3700MHz: identified for IMT in R2 in Canada, Columbia, Costa Rica and US. The band is available for IMT in CEPT without the ITU IMT identification. (fn 5.IMT2)

3700-3800MHz: NOC (no identification for IMT). The band is available for IMT in CEPT without the ITU IMT identification

AI 10 (topics for next WRC-19) (Res COM 6/16)

5G spectrum (Res COM 6/20)

AI 1.13 for 5G spectrum agreed with a following bands/ranges to be studied:

24.25-27.5 GHz, 37-40.5 GHz, 42.5-43.5 GHz, 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz, 81-86 GHz (having Mobile Allocation) and

31.8-33.4 GHz, 40.5-42.5 GHz, 47-47.2 GHz (not having Mobile Allocation).

Comments

- *Bands between 6-24GHz were not discussed on band-by-band basis and all bands were excluded from ITU studies, regardless of support from ATU region and many countries (Japan, FIN, SWE, SNG)*
- *Band 27.5-29.5 GHz was extensively debated and strong support from USA and KOR (and Japan) faced opposition from others and band was excluded from ITU studies*

HAPS (Res COM 6/21)

AI 1.14 for High Altitude Platform Stations (HAPS) was agreed and as there are already spectrum identified (but no implementations done so far) for HAPS, WRC-19 will concentrate on those bands already identified for HAPS but if HAPS would need more spectrum, the following bands are subject to study:

on a global level: 38-39.5 GHz, and

on a regional level: in Region 2, 21.4-22 GHz and 24.25-27.5 GHz

Exploring Spectrum above 6GHz



Spectrum above 6GHz: WRC-15 outcome and FCC NPRM

WRC-15 Outcome: Agenda Item for 5G spectrum with a list of bands to be studied towards WRC-19:

- Bands with Mobile Allocation:
 - 24.25 - 27.5 GHz
 - 37 - 40.5 GHz
 - 42.5 - 43.5 GHz
 - 45.5 - 47 GHz
 - 47.2 - 50.2 GHz
 - 50.4 - 52.6 GHz
 - 66 - 76 GHz
 - 81 - 86 GHz
- Bands without an existing Mobile Allocation:
 - 31.8-33.4 GHz, 40.5-42.5 GHz and 47-47.2 GHz

FCC'S 2014 Notice of Inquiry:

- LMDS Band (27.5-28.35 GHz, 29.1-29.25 GHz, and 31-31.3 GHz)
- 39 GHz Band (38.6-40 GHz)
- 37/42 GHz Bands (37.0-38.6 GHz and 42.0-42.5 GHz)
- 60 GHz Bands (57-64 GHz and 64-71 GHz)
- 70/80 GHz Bands (71-76 GHz, 81-86 GHz)
- 24 GHz Bands (24.25-24.45 GHz and 25.05-25.25 GHz)



FCC's 2015 NPRM:

- 27.5-28.35GHz,
- 37.0-38.6 GHz,
- 38.6-40 GHz,
- 64-71 GHz

Lack of bands below ~24 GHz

FCC should consider more bands, especially < 28GHz (including below 6GHz) and >71GHz

Executive Summary of Nokia's Comments to 5G mmWave NPRM- Licensing (1/2)

- Criteria considered important guidelines, not bright line rules, allowing deviation where appropriate.
- Grant flexible use rights in 28 GHz and 39 GHz bands and auction “dormant” licenses. Oppose “overlay” auction proposal.
- Same service rules for 37 GHz as for 39 GHz. 37GHz: Oppose hybrid approach. Support combining 37 & 39GHz for 3GHz total.
- 66-71GHz should be licensed based on WRC-15 outcome. 64-66GHz unlicensed.
- At least 400MHz blocks. A single 850MHz block or (400 + 450MHz) in 28GHz; four blocks of 400MHz in 37GHz; two blocks of 500MHz + one block of 400MHz in 39GHz. If 37 & 39GHz are combined, six 500MHz blocks. Five 1GHz blocks in 66-71GHz.
- Retain larger areas in 28 GHz (BTAs) and 39 GHz (EAs) and adopt similar large areas (EAs) in 37 GHz & 66-71GHz.

Executive Summary of Nokia's Comments to 5G mmWave NPRM- Licensing (2/2)

- Satellite operations should not harm 5G services. Should not adopt use of a Spectrum Access System. Instead, use market based mechanism for coexistence/coordination.
- Substantial service or usage based requirement instead of a POP coverage performance metric. Oppose “use it or share it”.
- Support 10 years license terms with renewal expectancies.
- Support secondary market transactions and also pre-auction swaps for large contiguous spectrum blocks.
- FCC should also reconsider other bands >24GHz like 24.25-29.5 GHz, 71-76/81-86GHz.
- FCC should also consider bands below 24GHz, including below 6GHz like 3.7-4.2GHz & 3.1-3.55GHz. Combined with 3.5GHz (3.55-3.7GHz), this will open 1.1GHz of contiguous spectrum below 6GHz. Another band of interest is the 1300-1390 MHz band.
- Keep backhaul needs in mind.

Executive Summary of Nokia's Comments to 5G mmWave NPRM- Technical (1/2)

- 28/37/39GHz/64-71GHz: Proposes to align BS transmit power with fixed point-to-point and point-to-multipoint systems (85dBm EIRP).
- Supports + 43 dBm EIRP for mobile devices.
- Tentatively proposes to add a category of devices (e.g., CPEs) which would have higher power limits [e.g., 53dBm] than mobile devices but lower power limits than base stations, recognizing need for RF exposure studies.
- Out of Band Emission of -13dBm/100kHz for first one MHz and -13dBm/1MHz at 1MHz offset or larger. Should not use bandwidth dependence resolution bandwidth in first 1MHz (use -13dBm/100kHz).
- FCC should not establish field strength or power flux density limits at geographic service area borders at this time for bands without incumbent licensees. Coordination for bands with incumbents.

Executive Summary of Nokia's Comments to 5G mmWave NPRM- Technical (2/2)

- Consideration of IEEE C95.1-2005, as updated by IEEE C95.1a-2010, as the applicable RF exposure standard for the proposed bands and continue to study RF exposure issues related to mmW in the context of the Commission's other open proceeding (ET Docket Nos. 13-84, 03-137) examining its RF exposure rules and policies. Guidance on how to demonstrate compliance with the Commission's exposure limits evaluation is to be issued by the FCC Laboratory.
- Nokia supports TDD in these bands. May also support FCC's proposal to be flexible and let market decide while noticing the advantages of TDD at these frequencies.
- Important to address 5G Security.
- 5G/Fixed Satellite Coexistence study filed by ViaSat is not accurate. Nokia will share its study when done.

Nokia is working with Verizon, AT&T and Satellite Industry Association on FSS/5G coexistence issues to come to an agreement.

Summary

•Below 6GHz:

- 600 MHz (70-100MHz)
- Current shared 3.5GHz (150MHz @ 3550-3700MHz). FSS and DoD incumbents.

Future (require lobbying):

- Add 3700-4200MHz. 650MHz contiguous (3550-4200MHz). FSS incumbent.
- Consider also 3100-3550MHz. 1100MHz contiguous (3100-4200MHz). DoD incumbent.
- 1300-1390MHz (to be paired with spectrum above 1780MHz)
- Additional 195MHz (5350-5470 MHz & 5850-5925 MHz) at 5GHz.
 - 775MHz contiguous @ 5GHz.

• Above 6GHz:

- Consider FCC's mmWave bands.
 - 27.5-28.35GHz,
 - 37.0-38.6 GHz,
 - 38.6-40 GHz,
 - 64-71 GHz
- FCC should also consider other bands in 24-86GHz range like 24.25-29.5 GHz, 71-76/81-86GHz.
- FCC should also consider bands in 6-24GHz.

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Regulations for the 5 GHz Band in the US



- U-NII-1: 5.150 GHz to 5.250 GHz
 - Max conducted power limit of 1 W with 6 dBi antenna gain
 - EIRP limit of 125 mW for elevation angle above 30° in outdoor deployments
- U-NII-2A: 5.250 GHz to 5.350 GHz
 - Max conducted power limit of 250 mW with 6 dBi antenna gain and TPC (Earth exploration satellite service)
 - DFS required (Federal radar)
- U-NII-2C: 5.470 GHz to 5.725 GHz
 - Max conducted power limit of 250 mW with 6 dBi antenna gain and TPC (Earth exploration satellite service)
 - DFS required (Federal radar)
- U-NII-3: 5.725 GHz to 5.825 GHz
 - Max conducted power limit of 1 W with 6 dBi antenna gain